

DOCUMENT RESUME

ED 296 562

EC 210 331

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TITLE The Development of Explicit and Implicit Forms of
Memory in Learning Disabled Children.
PUB DATE 88
NOTE 25p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Academic Achievement; Age Differences; Elementary
Education; Individual Differences; *Learning
Disabilities; *Learning Processes; *Memory; *Recall
(Psychology); Retention (Psychology)

ABSTRACT

Cognitive theorists distinguish between two forms of memory. Explicit memory, requiring the conscious reinstatement of episodic memories, is manifested on traditional tests where the student is asked to retrieve information previously learned. Implicit memory is evoked when task completion is facilitated by prior experience with a similar task. Two groups of learning disabled (LD) and two groups of nonlearning disabled students in grades 3 and 6 (N=60) were compared on a series of three tasks measuring picture memory. Results confirmed the hypothesis that significant effects of grade and subject group would be observed with the two tasks requiring explicit memory, while no differences would be observed on the implicit memory task. Significant grade and developmental differences were observed in an initial picture naming task which provided a measure of the speed with which the student is able to gain access to name codes in long-term memory. Similarly, in a follow-up task requiring free recall of as many of the pictures as possible, older children remembered a greater number than younger children, and nondisabled children remembered more items than LD children. These developmental and individual differences were eliminated in the fragment completion test, which relied on implicit memory. (JW)

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The Development of
Explicit and Implicit Forms of Memory
in Learning Disabled Children

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Abstract

Cognitive theorists have recently described two forms of memory. One is termed "explicit" memory and requires the conscious reinstatement of episodic memories, while the other form of memory is referred to as "implicit" (e.g., Graf & Schacter, 1985). The present study tested the hypothesis that tasks requiring the use of "explicit" forms of memory are sensitive developmental and individual differences, whereas tasks requiring "implicit" memory are not. Learning disabled children enrolled in the third and sixth grades were compared with third and sixth grade non-disabled children on a series of picture memory tasks. The original hypothesis was confirmed, with significant effects of grade and subject group being observed with explicit memory tasks (naming speed, free recall, and cued recall), but no differences on a fragment completion task.

The Development of
Explicit and Implicit Forms of Memory
in Learning Disabled Children

Investigators from diverse fields of study have recently distinguished between two forms of memory. A variety of terms have been used to describe this dichotomy, including explicit versus implicit memory (Graf & Schacter, 1985, 1987; Schacter & Graf, 1986a,b), memory with versus memory without awareness (Jacoby & Witherspoon, 1982), autobiographical memory versus perceptual fluency (Jacoby & Dallas, 1981), and declarative versus procedural knowledge (Cohen, 1984; Cohen & Squire, 1980; Squire & Cohen, 1984). The current research adopts the framework of Graf and Schacter (1985, 1987) by using the terms "explicit" and "implicit." Explicit memory is manifested on traditional tests, such as free recall, cued recall, and recognition, where the individual is asked explicitly to retrieve information that was studied during a recent learning episode (e.g., "Was the word 'BUFFER' on the preceding study list?"). In contrast, implicit memory is expressed on those tasks that do not require the conscious reinstatement of episodic memories. Rather than being asked to consciously bring to mind recent events, the subject is merely asked to complete a task that is sensitive to the effects of prior experience. Implicit memory is revealed if recent events facilitate performance on a task that does not make explicit reference to earlier experiences. For example, instead of being asked to recall words from a previous study

list, the subject might be presented with a series of word fragments (e.g., B U _ _ E R) and asked to respond to each fragment with the first word that "comes to mind." As a result of reading the earlier example of an explicit memory question, the reader of this paragraph is likely to use the word "BUFFER" to complete the above word fragment. Not having read the preceding example, the reader would be more apt to respond with "BUTTER," a word that occurs more frequently in our language (cf. Howard, In press). When the effect of a recent experience facilitates performance on a word fragment test it is presumed to reflect the operation of implicit forms of memory. Measuring the effects of implicit memory is not restricted to fragment completion tasks. Implicit memory is manifested on a variety of tasks, ranging from savings during relearning, to the subliminal perception of stimulus information (see Schacter (1987) for an excellent review).

The question of whether explicit and implicit memories depend upon a single underlying system or on multiple underlying systems remains to be answered (Schacter, 1987). In either case, recent research has identified both similarities and differences between explicit and implicit memories. For example, both forms of memory are similar in that each is affected by newly formed associations and each depends upon some degree of semantic elaboration at the time of study (Graf & Schacter, 1985). On the other hand, the two forms of memory differ in that one's performance on an

implicit task is often statistically unrelated to one's performance on an explicit measure (e.g., Tulving, Schacter, & Stark, 1982). Furthermore, the two memories differ significantly in their sensitivity to both individual and adult developmental differences. Recent studies have found that while individual and adult developmental differences are present when tasks are used that require explicit forms of memory, these differences are absent when an implicit measure is used (e.g., Warrington & Weiskrantz, 1968; Light, Singh, & Capps, 1986). In the study conducted by Warrington and Weiskrantz (1968), the memory skills of amnesic patients were examined by presenting sequences of fragmented pictures or fragmented words. Each subject was presented initially with the most incomplete version of each item and was asked to provide the item's name. If the subject could not provide the correct name for the stimulus, a succession of more complete versions were provided until the item was correctly identified. Subjects were repeatedly tested with the same procedure in order to measure learning and retention. Warrington and Weiskrantz found that there was substantial savings during relearning when the amnesics were tested with either the picture or the word fragments cues.

Research examining the memory skills of learning disabled children has been devoted primarily to the examination of explicit memory ability. When compared to their non-disabled peers, learning disabled children recall less information (e.g., Ceci, Lea, & Ringstrom, 1980;

Lorsbach, 1980), are less accurate in their recognition of prior events (Lorsbach & Gray, 1985), display short-term memory difficulties (e.g., Lorsbach & Gray, 1986; Torgesen & Houck, 1985), engage in less semantic processing (e.g., Ceci, 1983, 1984; Lorsbach, 1980), and fail to use such memory strategies as rehearsal (Bauer, 1977; Hallahan, Kauffman, & Ball, 1973) and organization (Bauer, 1982; Suiter & Potter, 1978). The results of these and other studies offer abundant evidence that learning disabled children are deficient on traditional tests that require explicit memory of prior events. Unfortunately, research is unavailable that provides information about the performance of learning disabled children on implicit memory tasks. Theoretical accounts of the nature of memory difficulties in learning disabled children are incomplete without information regarding performance on implicit memory tasks.

The present study compared learning disabled and non-disabled children in grades 3 and 6 on a series of three tasks that measured picture memory. The first two tasks required the conscious, "explicit" reinstatement of events within a prior learning episode (e.g., free recall and cued recall). A third, "implicit" memory task was included (fragment completion) that did not require children to consciously recollect those specific pictures that had been recently presented. The fragment completion task consisted of the presentation of a set of pictures, with each picture being represented by a graded series of four incomplete line

drawings. The subject's task was to guess the identity of each picture by providing the first name that "came to mind." Based upon the framework of Graf & Schacter (1985), both developmental and individual differences were anticipated on tasks measuring "explicit" forms of memory, but not with the task requiring an "implicit" form of remembering.

Method

Subjects. Sixty students were selected from a predominantly white, suburban school district in Omaha, NE. These 60 students consisted of 4 groups of 15 students each: third grade non-disabled (11 boys and 4 girls); third grade learning disabled (12 boys and 3 girls); sixth grade non-disabled (8 boys and 7 girls; and sixth grade learning disabled (11 boys and 3 girls).

Students in the non-disabled (non-LD) groups had been tested with the California Achievement Test and were found to be achieving at or above their current grade placement in all academic areas and were not receiving special education services at the time of testing. Third grade non-LD children had a mean total reading level of 5.4 (SD = 1.32), a mean total math level of 5.8 (SD = 1.64), and a total grade equivalency of 5.7 (SD = 1.42). Sixth grade non-LD children had a mean total reading level of 6.8 (SD = 1.1), a mean total math level of 6.0 (SD = .74), and a mean total grade equivalency of 6.5 (SD = .78). The mean chronological ages for the third and sixth grade non-LD children were 9.3 (SD = .48) and 12.2 (SD = .32), respectively. The data obtained

from group administered tests indicated that the third graders had a mean IQ of 113 ($SD = 12$) on the Test of Cognitive Skills and that the sixth graders had a mean mental age equivalent of 13.2 ($SD = 1.8$) on the Short Form Test of Academic Ability.

The learning disabled (LD) students had been previously identified by school district personnel as having a primary handicap in spoken and/or written language and were receiving services at the time of testing. Verification of a learning disability by school district personnel was based primarily upon two criteria: (1) the child scored above the minus 1 standard deviation level on an individually administered intelligence test and (2) the child's standard score in one or more academic areas was 1.3 or more standard deviations below the child's ability level. LD children were selected whose Performance IQ exceeded their Verbal IQ on the WISC-R. The third grade LD students had a mean chronological age of 9.2 ($SD = .31$), and mean Verbal and Performance IQ scores of 92 ($SD = 13$) and 115 ($SD = 15$), respectively. Sixth grade students had a mean chronological age of 12.2 ($SD = .37$) and a mean Verbal and Performance IQ of 89 ($SD = 9.3$) and 110 ($SD = 12.2$), respectively. Academic performance had been assessed with the Woodcock-Johnson Achievement Test and indicated that the third graders had a mean total reading level of 2.5 and a total math level of 3.0 ($SD = .8$). The sixth grade LD students had a mean total reading level of 4.8 ($SD = 1.08$) and a mean total math level of 5.6 ($SD = 1.0$).

Materials and apparatus. A Set (A) of 33 black-and-white line drawings (Snodgrass & Vanderwart, 1980) was formed, 28 of which consisted of 7 exemplars from each of the following 4 categories: vehicles, carpenter's tools, animals, and clothing. The remaining 5 items were categorically unrelated to the other 28 pictures and to each other. The formation of a second Set (B) was accomplished by removing 1 exemplar from each category of Set A and replacing it with a new exemplar. In addition, 2 of the 4 non-categorical items of Set A were replaced with new, unrelated items. This procedure resulted in the creation of 2 Sets, with each Set containing 6 items not found in the alternate Set of items. Of these 6 pictures, 4 served as critical items in the fragment completion task. Both Sets were equal in their familiarity and complexity (Snodgrass & Vanderwart, 1980) and each of the category exemplars were included in norms for third and sixth grade children (Posnansky, 1978). Each Set was used equally often across subjects.

Eight pictures were used in the fragment completion task and consisted of 4 critical items from each of the 2 Sets. Of the 4 critical items selected from Set A, 1 picture each represented the categories of clothing (pants) and vehicles (car), while the 2 remaining pictures were unrelated items (house, tree). The 4 items from Set B were obtained from the categories animals (rabbit) and tools (saw), while the remaining 2 items were unrelated (apple, clock). For each of the 8 pictures, 4 fragmented versions were created, ranging

from very incomplete to nearly complete. Figure 1 presents the fragmented versions that were used for the pictures "rabbit" and "saw." Based on pilot data, the fragmented pictures that were selected were comparable in their level of difficulty. Depending upon which Set was studied, 4 of the 8 items in the fragment completion task were "old" (i.e., taken from the previously studied Set) and 4 were "new" (i.e., not previously studied. Each picture was used equally often as "old" and "new", resulting in the pictures serving as their own controls.

Insert Figure 1 about here

All stimuli were presented on slides via a Kodak carousel projector that was linked to a millisecond clock. For each subject, the naming latency of each stimulus was recorded through the use of a voice operated relay system.

Procedure. Each subject was tested individually and was initially shown a sequence of individual pictures from either Set A or Set B. Each subject was instructed to name each picture as quickly as possible and to prepare themselves for a forthcoming memory test, the nature of which was not further specified. The pictures were presented individually with an exposure duration of 5 seconds per item. The experimenter recorded both the accuracy and latency of response to each picture.

Upon completion of the study list, a free recall task

was administered in which the subject was asked to recall aloud as many of the pictures as possible, in any order that came to mind. No time restrictions were placed upon subjects for the completion of this task.

Following the the free recall task, each subject was given a cued recall task. Subjects were informed that most of the pictures that had been presented for study belonged to one of several different categories. The subject was then requested to recall as many pictures as possible when cued with each of the four category labels.

The final task was not presented as a memory test, but rather as a game. The fragment completion task was presented to the subject as a "guessing game" where they were asked to determine the identification of 8 incomplete pictures. Instructions did not indicate whether any of the pictures had been presented on the preceding study list. The 4 fragmented versions of each picture were presented successively at a rate of 1 fragmented picture every 8 seconds. Subjects were encouraged to guess freely as to the identity of each fragmented picture. All subjects were presented with the same randomized sequence of 8 fragmented pictures.

Results

Data from each of the memory tasks was analyzed separately in a 2 x 2 completely randomized factorial design, with grade (third and sixth) and group (LD and non-LD) as the between subjects factors.

Picture naming task. Each subject's median naming

latency was computed and submitted to an analysis of variance. There were significant effects of grade, $F(1,56) = 8.172$, $p < .006$, and group, $F(1,56) = 10.813$, $p < .002$, indicating that the pictures were named significantly faster by sixth graders ($M = 881$ msec) than by third graders ($M = 965$ msec) and that the non-LD children ($M = 874$ msec) responded more rapidly than the LD children ($M = 970$ msec). No differences were observed in picture naming accuracy.

Free recall task. Analysis of the number of pictures recalled by each subject revealed that the effects of both grade, $F(1,56) = 18.643$, $p < .001$, and group, $F(1,56) = 19.404$, $p < .001$, were each significant. These results indicate that the sixth graders ($M = 14.03$) recalled more pictures than third graders ($M = 10.73$), and that the non-LD children ($M = 14.06$) recalled significantly more pictures than the LD children ($M = 10.7$).

Cued recall task. The analysis of the mean number of pictures recalled per category resulted in significant effects being observed with both grade, $F(1,56) = 21.162$, $p < .001$, and group, $F(1,56) = 16.143$, $p < .001$. As with the free recall task, the sixth graders ($M = 3.88$) recalled a greater number of pictures per category than the third graders ($M = 3.09$), and that the non-LD children ($M = 3.83$) recalled more pictures than the LD children ($M = 3.14$).

Fragment completion task. A scoring system was set up such that a high score indicated early, successful identification of the fragmented picture. For each subject,

a corrected score was obtained in order to isolate the effect of previous study upon the completion of "old" fragmented pictures. For each subject, this corrected score was calculated by subtracting the raw score on the "new" items (baseline performance) from the raw score on the "old" items. The analysis of these corrected scores revealed no main or interactive effects of grade level or group. Both the third and the sixth grade LD groups obtained a mean corrected score of 1.86. The mean corrected scores for the third and sixth grade non-LD groups were 1.33 and 1.80, respectively. Correlational analyses indicated that performance on the fragment completion task did not correlate significantly with performance on the the free recall task or the cued recall task.

Discussion

The results of the present experiment are consistent with the findings of earlier studies in showing that tasks requiring explicit forms of memory are sensitive to both developmental and individual differences, whereas tasks that rely upon implicit forms of memory are insensitive to such differences. In this case, when tasks required children to consciously retrieve the names of recently studied pictures, older children remembered a greater number of pictures than younger children, and non-disabled children remembered more items than LD children. These differences were similarly observed during the initial picture naming task, a procedure which provides a measure of the speed with which one is able

to gain access to name codes in long-term memory. These developmental and individual differences were eliminated in the fragment completion test, a task that does not require deliberate or conscious retrieval of episodic memories. The fact that success in the fragment completion task was found to be independent of whether or not old items had been remembered in either of the recall tasks, indicates that the explicit memory tasks assessed different aspects of memory than the implicit memory task of fragment completion.

The dissociation between recall and fragment completion performance is perhaps best interpreted according to a memory framework that has been presented in various forms by Mandler (1979; 1980; Graf & Mandler, 1984) and Jacoby (1982; Jacoby & Dallas, 1981; Jacoby & Witherspoon, 1982). The model of Graf and Mandler (1984) begins with the observation that the mental representation of an event consists of both perceptual and semantic components, and their relationships. When an item such as a word or picture is presented for study, its internal schema is activated through the use of two processes. The first process is that of "integration." Integration is considered to be an automatic process that involves the strengthening of a schema's intraitem components and their organization. Such integrative processing results in the schema being more "accessible" in the sense that it is more apt to be identified or "come to mind" when only partial or minimal information is provided. The second form of processing is referred to as "elaboration" and involves the

formation of new interitem relationships. Elaboration is considered to be a conscious form of processing that enables the subject to associate an event with the context in which it occurred. While integrative processing makes an item's schema more accessible, elaborative processing is considered to enhance both accessibility and retrievability of the item.

Graf and Mandler (1984) would argue that the dissociations between the recall tasks and the fragment completion task in the current study were due to the different informational requirements of the tasks. The fragment completion task presented partial picture information and required the subject to respond with the first name that "came to mind." When the picture fragment was presented, it activated the components of all pictures having a similar configuration. Because the schemas of study list items had been recently activated, the identity of fragments of recently studied pictures came to mind sooner than the fragments of new pictures. Due to the fact that subjects were instructed to treat the fragment completion task as a "guessing game", and were not asked to use the fragments as retrieval cues, the task primarily reflects integrative processing in the form of item accessibility. The recall tasks, on the other hand, required subjects to consciously reinstate information about events that had appeared in the context of the recent study episode. In this case, an item's accessibility cannot in and of itself result in successful performance. The subject must use retrieval

information to gain access to the episodic events stored in memory. The ability to explicitly retrieve episodic memories is largely dependent upon elaborative processing and the use of contextual information.

Finding developmental and individual differences on tasks that are dependent upon elaborative processing only serves to reinforce a common finding in the child development literature and in the research on learning disabilities (e.g., Ceci, 1983; Lorschach, 1980). The results of the present investigation are unique in that they demonstrate that a failure to engage in elaborative processing affects retrieval of the item and not its accessibility. Also significant is the identification of a form of memory that is not affected by the presence of a learning disability or by the age of the child, at least with the ages studied here. Previous research is replete with studies finding various memory deficits in learning disabled children. Future research efforts will want to also identify those processes that are spared in these children.

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Author Notes

The research reported here was funded by a Summer Research fellowship awarded to the first author by the University Committee on Research, University of Nebraska at Omaha. The results reported here were also presented at the annual meeting of the American Educational Research Association, New Orleans, 1988. Correspondence regarding this article should be sent to Tom Lorschach, Department of Counseling and Special Education, 117 Kayser Hall, University of Nebraska at Omaha, Omaha, Nebraska 68182-0167.

Figure Caption

Figure 1. Examples of pictures used in the fragment completion task: "Rabbit" and "Saw."

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